NEW SPECIES OF MOLLUSCA FROM EASTERN AUSTRALIA

By T. A. GARRARD *

Pl. 7, figs. 1-10

The continual discovery of new species of molluscs on the eastern coast of Australia, mainly by dredging and trawling in deep water, is rather astonishing, especially when coupled with the finding of many named species not previously recorded from Australia. I refer mainly to large shell-bearing molluscs, apart from recent discoveries amongst the Nudibranchia and other molluscan fauna, and doubtless many smaller species will come to hand during the next few years.

Although a number of well known species, including many formerly thought to be indigenous to Japan, have been found living off the coast of Queensland during the past two or three years, unfortunately only a few have come into the possession of the Australian Museum, and it is therefore not considered desirable to list the names at this time. However, several new species which I have acquired during this period are described below, and the types in each case have been presented to the Australian Museum.

CLASS PELECYPODA (LAMELLIBRANCHIA)
SUBCLASS TELEODESMACEA
FAMILY CARDIIDAE

REGOZARA Iredale 1936, *Rec. Aust. Mus.*, 19: 275. Type species by original designation *olivifer* Iredale.

Regozara fraseri sp. nov.

(Pl. 7, fig. 1)

Remarks: This species, apart from the heavy periostracum, bears a superficial resemblance to the well known *Regozara racketti* Donovan, but the sculpture is quite distinctive. The specimens were obtained from the former well known prawning ground east of Tin Can Bay several years ago, and specimens from other localities have so far not come under notice.

Description: Shell equivalve, inequilateral, swollen, produced posteriorly and slightly truncated, anterior end rounded and slightly produced near lunule; exterior ligament; sculpture of about 37 sharp radiating ridges extending from umbos to ventral margin, each covered with sharp vertical prickles, with a well defined square sided channel in each interstice; flat topped ribs well defined in interior; muscle scars small and close to margins, pallial line and sinus indiscernible. Colour off-white tinged with red-brown at posterior end, interior white. Periostracum dark brown and heavy.

Dimensions: Holotype, length 37 mm., height 36 mm., section of conjoined valves 29 mm.

Type locality: Trawled in 35 fathoms east of Tin Can Bay, south east of Fraser Island, Queensland.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 64068 with one paratype; three paratypes in author's collection.

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* 3 The Circle, Dundas, N.S.W.

FAMILY DOSINIIDAE

PARDOSINIA Iredale 1929, *Mem. Qd. Mus.*, 9: 264. Type species by original designation *colorata* Iredale.

Pardosinia extranea Iredale 1937.

(Pl. 7, figs. 2, 3)

Pardosinia alma extranea Iredale, 1937, *Aust. Zool.*, 8: 241.

Remarks: In naming a single valve of this sub-species of *Pardosinia alma* Iredale from Michaelmas Cay, Q., it was stated that the variation seen, narrower and with finer sculpture, was not fully understood, and Iredale adopted his usual practice of naming it as a sub-species pending further material coming to hand. A large series of live specimens dredged in the lagoon at Lady Musgrave Island confirms the differences between *Pardosinia alma* and *P. extranea*, and it is considered that *extranea* should now be elevated to full specific rank. Two specimens are figured to show the great variation which can occur in the pattern, always red-brown on a white ground.

CLASS GASTROPODA

SUBCLASS PROSOBRANCHIA

FAMILY CYMATIIDAE

LINATELLA Gray 1857. *Guide Syst. Dist. Moll. Brit. Mus.* p. 39. Type species by monotypy *Linatella cingulata* Lamarck.

Linatella neptunia sp. nov.

(Pl. 7, figs. 7, 8)

Remarks: This species first came to notice about four years ago and is apparently still a rare shell, only four having been noted in addition to the holotype. It is closely related to *Linatella cingulata* Lamarck, which differs in having flat topped ribs and interstitial spiral threads between the ribs, as opposed to the well rounded ribs and lack of threads on this new species. Unfortunately only one specimen of *Linatella cingulata* has been available to me for comparison, and contrary to the original description stating that it possesses a straight anterior canal, the canal in this specimen is well recurved, similar to the five specimens seen of this new species.

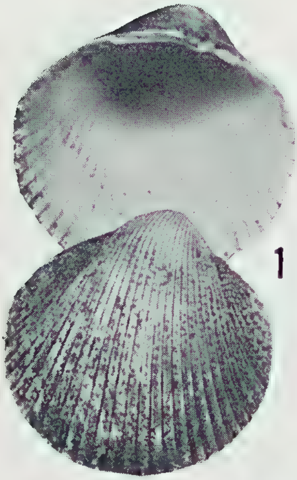
Description: Shell of five main whorls, apex missing, whorls shouldered, spire fairly elevated, sutures a little impressed, mouth wide and open, anterior canal short and wide, columella straight, inner lip greatly reflected at anterior end and with heavy callus at posterior end; umbilical chink present; sculpture of sixteen heavy encircling cords on body whorl, five or six on other whorls, one heavier and somewhat nodular whorl forming the well defined shoulder, the whole crossed by irregular growth lines; outer lip a little thickened and reflected; interior fluting corresponding to exterior cords is carried well into mouth of shell; colour off-white.

A specimen in the collection of Mrs. M. Bowman of Yeppoon, Q., carries a strong lamellate varix on body whorl in line with inner lip, not present in other specimens.

Dimensions: Holotype, length 60 mm., breadth 34 mm., aperture 42 mm.

Type locality: Trawled in 30 fathoms off Southport, Q.

Types: Holotype presented to the Australian Museum, Sydney, by courtesy of Mr. P. McI. Forrest of Toowong, Brisbane. Registered No. C. 62522. One paratype in author's collection from 30 fathoms off Tweed Heads, N.S.W., and two from 35 fathoms off Tin Can Bay, south east of Fraser Is., Q.



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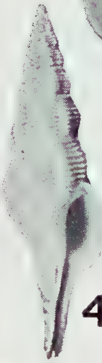

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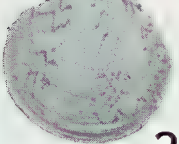

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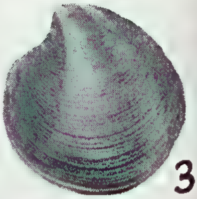

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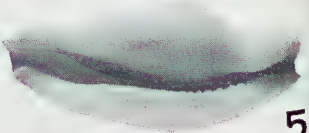

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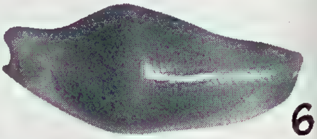

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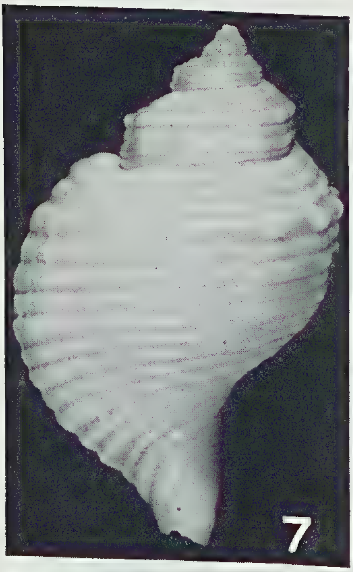

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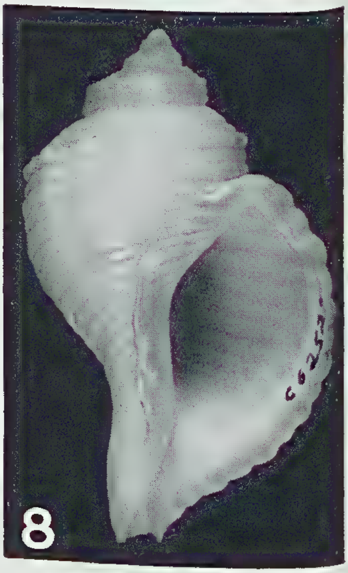

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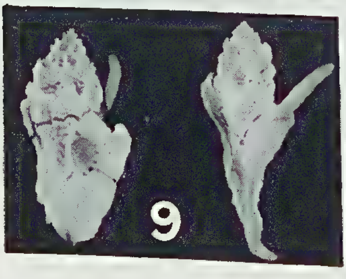

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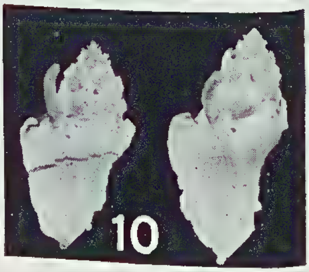

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PLATE 7

SUPERFAMILY CYPRAEACEA
FAMILY OVULIDAE
SUB-FAMILY VOLVINAE

NEOSIMNIA Fischer 1884, *Man. de Conch.*, p. 664. Type species by original designation *spelta* Linné 1758.

Neosimnia tinctura sp. nov.

(Pl. 7, figs. 5, 6)

Remarks: This beautiful little species joins *N. formicaria* Sowerby and *N. subreflexa* Adams and Reeve as a third species of this interesting genus to be found on the eastern Australian coast. All appear to live on the narrow branches of gorgoniae and small types of coral, and this new species is no exception, being found on gorgoniae in Moreton Bay, Q. However, the species appears to be fairly widespread as the author has also found worn specimens on beaches at Yeppoon and near Burnett Heads, Q.

Description: Shell elongated and roughly cylindrical in shape, with carinated angle above the centre, extremities blunt, outer lip thickened and calloused; aperture widens anteriorly; fossula smooth and prominent, forming a distinct keel on columella; fairly strong labial teeth at posterior end, becoming weaker and disappearing entirely at anterior end; dorsal surface entirely covered with fine wavy striations; general coloration fawn, with narrow whitish band encircling the carination; further indistinct whitish bands towards either end, the extremities themselves tipped with bright reddish-orange, outer lip bright yellow, fossula bright pink.

The bright reddish-orange extremities are a distinguishing feature of this shell, persisting even in well worn specimens.

Dimensions: Holotype, length 9 mm., width 4 mm.

Type locality: Living on the alcyonarian *Mopsella* in 7-8 fathoms, Moreton Bay, Q.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 64070, together with several paratypes, and several others in author's collection.

FAMILY FASCIOLARIIDAE

LATIRUS Montfort 1810, *Conch. Syst.*, 2: 530-531. Type species by original designation *gibbulus* Gmelin.

Latirus thesaurus sp. nov.

(Pl. 7, fig. 4)

Remarks: This fine species adds a second to the genus for the State of New South Wales, the only other recorded being *L. turritus* Gmelin, and is a somewhat surprising find for the locality, which has been trawled for so many years in the depth at which the specimen was found.

Fig. 1. *Regozara fraseri* sp. nov. Holotype. Aust. Mus. No. C. 64068.

Figs. 2, 3. *Pardosinia extranea* Iredale. Lady Musgrave Island. Aust. Mus. No. C. 64069.

Fig. 4. *Latirus thesaurus* sp. nov. Holotype. Aust. Mus. No. C. 64071.

Figs. 5, 6. *Neosimnia tinctura* sp. nov. Holotype. Aust. Mus. No. C. 64070.

Figs. 7, 8. *Linatella neptunia* sp. nov. Holotype. Aust. Mus. No. C. 62522.

Fig. 9. *Typhisopsis occlusum* sp. nov. Holotype (left) and Paratype (right).

Fig. 10. *Typhisopsis occlusum* sp. nov. Holotype (left, Aust. Mus. No. C. 64072) and Paratype (right, T. A. Garrard Collection).

Description: Shell fairly narrow and fusiform, of eight main whorls with simple smooth protoconch of one whorl, merging gradually into sculpture of main whorls, which are somewhat convex, sutures impressed; sculpture consists of strong axial plications, ten on penultimate whorl, diminishing in number towards the spire, and tending to disappear on body whorl; nine or ten raised spiral lirae on each whorl over-ridden by growth lines which become pronounced on body whorl; aperture narrow and half total length of shell, lip slightly reflected and showing slight indentations due to raised external lirae; anterior canal open, straight and narrow; colour uniform light brown, spiral lirae whitish, anterior end stained dark purple brown, interior of aperture pinkish brown.

Dimensions: Holotype, length 42 mm., breadth 12 mm., aperture 21 mm.

Type locality: Trawled in 40 fathoms east of Port Hacking, New South Wales.

Types: Holotype, the only known specimen, presented to the Australian Museum, Sydney, where it is registered No. C. 64071.

FAMILY TYPHIDAE

TYPHISOPSIS Jousseaume 1880, *Le Naturaliste*, year 2, pp. 335-6. Type species by original designation *coronatus* Broderip.

Typhisopsis occlusum sp. nov.

(Pl. 7, figs. 9, 10)

Remarks: Several specimens of this new species, rather old and beach worn, were first obtained by Mr. Tom Iredale some years ago on Lindeman Is., Q., but owing to their worn state it was decided to await better material. Two live specimens dredged in 17 fathoms off Hayman Is., in Whitsunday Passage, by Mr. Tom Nielsen, are fortunately in perfect condition, and are a fascinating addition to the Family on our coast.

Description: Shell is a typical *Typhis* as regards formation of the spire, with one open foramen between each varix. Whorls number six, flat topped, varices raised vertically in form of a hollow spine, each foramen joined to varix of preceding whorl, last foramen produced to half an inch in length, curving away from body whorl directly behind mouth of shell; protoconch of 1½ whorls, smooth, set at an oblique angle, merging gradually into main whorls; lip thin, greatly expanded and recurved; anterior canal completely closed except at extreme end and curved sharply back; mouth very small, produced and recurved all round; apart from peculiar flange-like varices and foramina, surface sculpture consists of irregular growth striae only; colour white shading to light creamy brown, dark spiral lines show through a white glaze over whole shell, a few brown marks on outer lip, one chocolate line encircles centre of each whorl in holotype, absent from paratype; operculum horny, light brown, broadly pear shaped, with strong ridges extending in waves from a terminal nucleus.

Dimensions: Holotype, length 27 mm., width 14 mm., aperture 4.5 mm. Paratype 31 x 16 mm.

Type locality: Dredged in 17 fathoms off Hayman Island in Whitsunday Passage, Q.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 64072; one paratype in author's collection.

ANATOMICAL NOTES ON *CYPRAEA AURANTIUM* GMELIN AND OTHER COWRIES AND AN EXAMINATION OF THE SUBGENUS *LYNCINA* TROSCHEL

By E. ALISON KAY *

Pl. 8, figs. 1-9, Text figs. 1-12.

INTRODUCTION

In June, 1962, I received a single preserved specimen of the golden cowry, *Cypraea aurantium* Gmelin, from Mr. F. Lahore of the Philippine Islands. The lack of anatomical knowledge of this species is in itself reason for a note on its anatomy, particularly since there are differences of opinion concerning the relationships of *C. aurantium*. In the course of the study it became apparent that *C. aurantium* resembles eight Indo-Pacific species in radular pattern, mantle characters, and genitalia. A survey of the literature disclosed that all nine species have been at one time or another associated with the cypraeid subgenus *Lyncina* of Troschel (1863). The purpose of the present paper has, therefore, become two-fold: to present anatomical descriptions of *C. aurantium* and species pertinent to a consideration of its relationships, and to re-examine Troschel's cypraeid subgenus *Lyncina*.

Lyncina Troschel 1863 lies within the maze of taxonomic superstructure which has arisen around the gastropods commonly known as the cowries (Cypraeinae, *sensu* Thiele, 1931; *Cypraea, sensu* Kay, 1960). Troschel, recognizing four genera of cowries, limited his concept of the genus *Cypraea* to those glossy-shelled species in which there is a spoon-shaped depression in the fossula. He further subdivided the genus into four subgenera on the basis of a combination of conchological and radular characters. The subgenus *Lyncina* originally included six species (*C. carneola, C. lynx, C. vitellus, C. camelopardalis, C. mappa,* and *C. argus*) which Troschel anatomically characterized as having the median radular tooth anteriorly distinctly rounded—"Mittelplatte vorn spitz abgerundet, die Seitenzahne der Schneide ebenso gross wie der mittlere Hauptzahn." (Troschel, 1863).

Lyncina Troschel has since been incorporated as a subgenus in the concepts of the genus *Cypraea* elaborated by Thiele (1931), Schilder (1939), and Schilder and Schilder (1938-1939), and has been raised to generic rank by Iredale (1935). Thiele (1931) modified Troschel's subgenus by removing *C. mappa* to a separate subgenus within his concept of *Cypraea,* but added both *C. aurantium* and *C. reevei.* The Schilders (1938-1939), while adding two species (*C. leviathan* and *C. ventriculus*), also excluded *C. mappa* and, in addition, removed *C. argus* and *C. aurantium,* placing the former in *Talparia* where it is grouped with *C. talpa* and *C. exusta,* and the latter in *Callistocypraea* with *C. testudinaria, C. nivosa, C. broderipi* and *C. leucodon.* Iredale (1935), followed by Steadman and Cotton (1946) and Allan (1956), raised *Lyncina* to generic rank, recognizing only one species, *C. lynx,* and distributed the other species which Troschel, Thiele, and the Schilders had associated with *Lyncina* among various genera.

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MATERIAL AND METHODS

Of the ten species which have been associated with *Lyncina,* eight will be described below; preserved specimens of *C. camelopardalis* and *C. ventriculus* were not available for the study. In addition, the anatomy of *C. testudinaria* and *C. talpa* will be described because of their association by the Schilders (1938-39) with *C. argus* and *C. aurantium.*

The mantle, radula, and genitalia have all been studied in animals preserved in 70% alcohol or 10% formalin without previous relaxation. Although there are various anatomical descriptions from several of the species, these are somewhat scattered in the literature, and new descriptions seem justified. I have not been able to detect differences in the ctenidia and osphradia, except in the case of *C. testudinaria,* and neither these structures nor the nervous system are included in the anatomical descriptions. Descriptive terminology for the mantle, papillae, and siphon is that of Schilder (1936). Where descriptions of living animals were available, these are included.

Radulae were prepared by mounting them unstained in Euparal. Although the oxidation-dahlia staining technique of Bowell has previously been utilized (Kay, 1960), I have found that unstained mounts in Euparal produce satisfactory results. Only fully formed teeth were included in the counts of radular rows; determination of the beginning of the nascent teeth was made by micrometer measurement and those teeth one-half the size of the majority in the radular ribbon were considered nascent.

Radular terminology is primarily that of Schilder (1936): the rachidan or central tooth is termed the median, the teeth bordering it the admedians, and the teeth flanking the latter the inner and outer marginals. The teeth are anteriorly tri-cuspid and the cusps will be referred to as central and lateral. I will refer to the posterior projections of the corners of the tooth as basal cusps, while those associated with an internal bract will be termed basal denticles. The internal bracts are dense portions of the tooth which form distinctive horizontal or vertical patterns within the body of the tooth.

Terminology referring to the genitalia is that of Kay (1960). The bursa copulatrix which is present in the females of a number of cowries is a typically pyriform structure at the terminus of the reproductive ducts.

ACKNOWLEDGMENTS

I am indebted to numerous people who have provided specimens of prized cowries for my studies. The specimen of *C. aurantium* was obtained through the perserverence of Mr. Karl Greene of Honolulu, Hawaii, who has for many years devoted himself to the pursuit of the golden cowry. The specimen of *C. mappa* was received from Mr. John Roberts of the Marshall Islands; that of *C. argus* from Mr. F. Dayrit of the Philippine Islands; and that of *C. testudinaria* from Dr. J. Knudsen of the Zoological Museum, Copenhagen. Many specimens of other species have been made available by Dr. C. M. Burgess of Honolulu, Hawaii. Living specimens of *C. lynx, C. vitellus,* and *C. carneola* were provided by Mr. Herbert Ward, formerly of Agana, Guam, and Mrs. James Andrus and Mrs. Arch Harrison of Honolulu, Hawaii.

DESCRIPTIVE ANATOMY

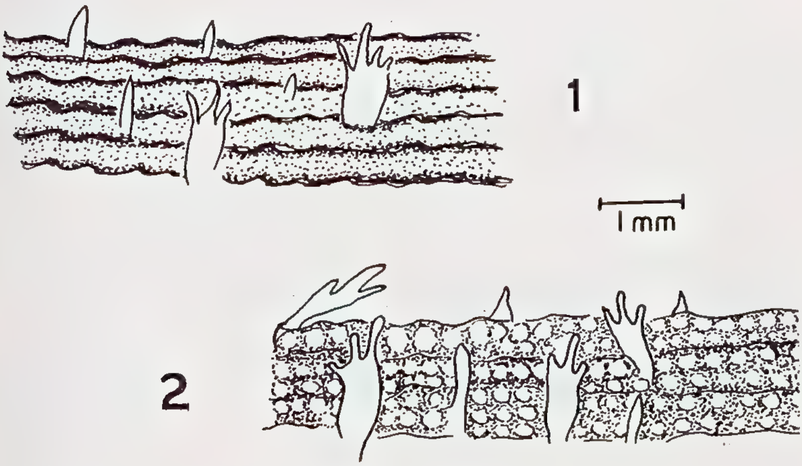
Cypraea argus Linnaeus

Fig. 1; Fig. 6a; Pl. 8, Fig. 7

Material examined. 1 specimen: length, 66 mm.; width, 35 mm.; height, 27 mm.; from a reef at Laminusa Siasi, Sulu, June, 1960.

Mantle. Preserved the mantle is creamy-brown reticulated and mottled with dark brown; the papillae are cream-coloured. The mantle surface is plicate, the somewhat irregularly spaced plaits running anteroposteriorly. The papillae are sparse, consisting of two types: small (1 mm. in length), simple, conical processes which are more numerous distally and 10 or 12 larger (2-3 mm.) dendritic papillae which occur proximally. The dendritic papillae rise from a single thick base and then branch into three or more small finger-like processes. The siphonal fringe is short, consisting of 20 evenly spaced serrations; on either side of the siphon there is a cluster of large (2-3 mm.) conical and dendritic papillae.

Radula. The radular ribbon is 16 mm. long, 2 mm. wide, and composed of 288 rows. The teeth are large, sturdy structures which overlap transversely and longitudinally in the anterior portions of the ribbon. The median tooth (.18 mm. long and .24 mm. wide) is semicircular; the cusps are broad and triangular; and the base is flaring. The anterior dome with cusps occupies two-thirds of the tooth, the cusps forming half of the dome; the cusps terminate evenly, the lateral cusps flaring toward the edges of the tooth. The admedians are of approximately the same dimensions as the median but are rectangular; the central cusp is larger than the lateral cusps and extends about half the length of the tooth body; medially there is a basal cusp which is oriented toward the median tooth but which does not overlap the median. The inner marginals (.15 mm. long; .30 mm. wide) are in the form of an inverted triangle, the base of the triangle consisting of the elongate central cusp which projects over the lateral cusp of the admedians and the shorter lateral cusps, and the apex consisting of the base of the tooth; the lateral cusps of the inner marginals are smaller than the central cusp. The outer marginals (.32 mm. long; .10 mm. wide) are narrow hook-shaped structures with a single central cusp which projects over the inner marginal tooth; a shorter lateral cusp emerges from the anterior quarter of the tooth and projects medially.



Figures 1 and 2

Figure 1, Mantle surface of *Cypraea argus* Linnaeus.
Figure 2, Mantle surface of *Cypraea vitellus* Linnaeus.

Genitalia. The specimen examined was a female; a bursa copulatrix is present; it is a pyriform structure 8 mm. long and 4 mm. wide.

Distribution. Indo-West-Pacific—from the coast of East Africa to the Line Islands in the Pacific, but excluding the Hawaiian Islands.

Cypraea aurantium Gmelin

Figs. 3, 4; Fig. 6b; Pl. 8, Fig. 1

Material Examined. 1 specimen: length, 93 mm.; width, 62 mm.; height, 53 mm.; from Dahikan coral reef, Manay, Davao, Philippine Islands, June 25, 1962.

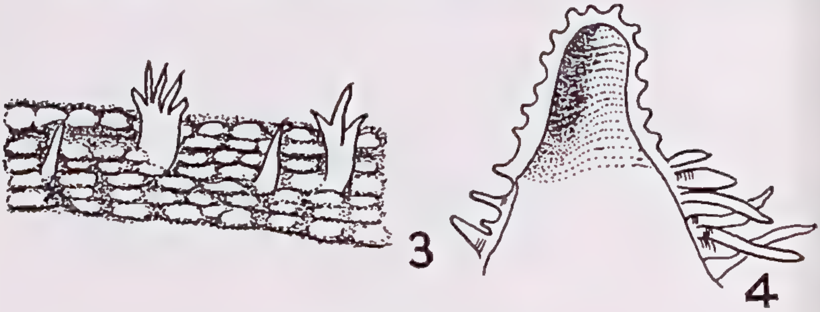
Mantle. Preserved the mantle is grey-black relieved by reticulations of white. The mantle is thick and finely plicate, the plications granulated by small pustules. The papillae are fairly prominent, sparse medially and more numerous near the foot. As in the preceding species there are two types of processes, some small (1 mm.) and simply conical, the others larger (2 mm.) and dendritic; both forms are equally intermingled. The siphon is simply fringed with 20 short, blunt serrations; on each side of the siphon there is a cluster of large, long (3 mm.) conical and dendritic processes; these are more numerous and larger on the left edge of the siphon than on the right.

Radula. The radular ribbon is 75 mm. long, 2.5 mm. wide, and composed of 243 rows. The teeth are massive; the median is .34 mm. long and .21 mm. wide; the admedians are of similar dimensions; the inner marginals are .30 mm. long and .42 mm. wide; the outer-marginals are .30 mm. long and .12 mm. wide. The medians are well-spaced longitudinally with the admedians overlapping the median and the marginals overlapping the admedians transversely and longitudinally. Tooth pattern is as in the preceding species.

Genitalia. The animal dissected was a female, and there is a bursa copulatrix present in the form of an oval structure which swells posterior to the vagina; it is 15 mm. long and 10 mm. in diameter.

Remarks: The dissection of the specimen of *C. aurantium* disclosed two colour features and a structural feature which are noteworthy. The stomach and intestine are black, a colour not previously noted in other specimens of *Cypraea,* and the cerebral ganglia are dark yellow, lacking the red-yellow spotting characteristic of most species of *Cypraea.* The foot is more prominently rugose than in other cypraeids which have been examined.

Distribution. Pacific Ocean-southern Philippines to the Society Islands.



Figures 3 and 4

Figure 3, Mantle surface of *Cypraea aurantium* Gmelin.

Figure 4, Siphon of *Cypraea aurantium* Gmelin.

Cypraea carneola Linnaeus

Fig. 6c; Pl. 8, Fig. 8

Material Examined. Living and preserved specimens from the Hawaiian Islands; preserved specimens from Kenya; Mauritius; Sulu Sea; Tahiti.

Living animal. The mantle is mottled red-brown; the papillae are somewhat lighter in colour than the mantle; the tentacles and proboscis are yellow; the dorsal surface of the foot is light brown. The papillae are sparse; three or four are feathery in appearance while others are simply conical. The siphon projects from the anterior canal as a short, simply fringed structure.

Mantle. Preserved the mantle retains its monotone appearance in Hawaiian specimens; it is mottled cream-white and black in specimens from other areas. The mantle surface is roughly plicate; it is studded with small, conical papillae and fewer, larger dendritic papillae. The siphon is simply fringed with short, tapering serrations; it is bordered by clusters of long conical and dendritic papillae. The siphon and mantle of a preserved specimen were well figured by Vayssière (1923).

Radula. The radular ribbon in six specimens varies from 10-14 mm. in length and from .75 to 1.5 mm. in width, and there are from 140-203 rows. The teeth are conspicuously small; the median is .06-.10 mm. long and .08-.12 mm. wide; the admedians are of similar dimensions; the inner marginals are .07-.09 mm. long and .06-.14 mm. wide; the outer marginals are .10-.15 mm. long and .03-.06 mm. wide. Tooth pattern is as in the preceding species.

Genitalia. A bursa copulatrix is present in the females; it is an oval pouch which extends anteriorly from the reproductive ducts. In the males the penis is a slender conical structure. The lateral basal projection figured by Vayssière (1923) has not been observed.

Distribution. Indo-West-Pacific, including the Hawaiian Islands.

Cypraea leviathan Schilder-Schilder

Fig. 5, Pl. 8, Fig. 9

Material Examined. Living and preserved specimens from the Hawaiian Islands.

Living Animals. The mantle is black, mottled with white; the papillae are cream-coloured and the proboscis and tentacles are black; the foot is grey-brown dorsally, red-brown ventrally. The papillae are numerous, some projecting as feathery tufts from the sides of the animal, others smaller, conical processes. The siphon projects from the anterior canal as a short, simply fringed structure.

Mantle. Preserved the mantle retains much of the black pigmentation noted in living specimens. The mantle surface is plicate and studded with numerous feathery, dendritic papillae which are occasionally interspersed with small, simple, conical papillae. The siphon is simply fringed by a series of short serrations; the siphonal fringe is bordered on each side by a cluster of large dendritic and conical papillae.

Radula. The radular ribbon from four specimens varies from 32-42 mm. in length, from 1-2 mm. in width, and from 206-251 in number of rows. The teeth, especially when compared with those of *C. carneola*, are large and well-spaced both longitudinally and transversely. Dimensions of the median tooth are .10-.16 mm. in length and .18-.25 mm. in width; the admedians are of similar dimensions; the inner laterals are .10-.17 mm. in length and .15-.24 mm. in width; and the outer laterals are .18-.30 mm. in length and .06-.12 mm. in width. Tooth pattern is as in the preceding species. The individual teeth are distinguished from those

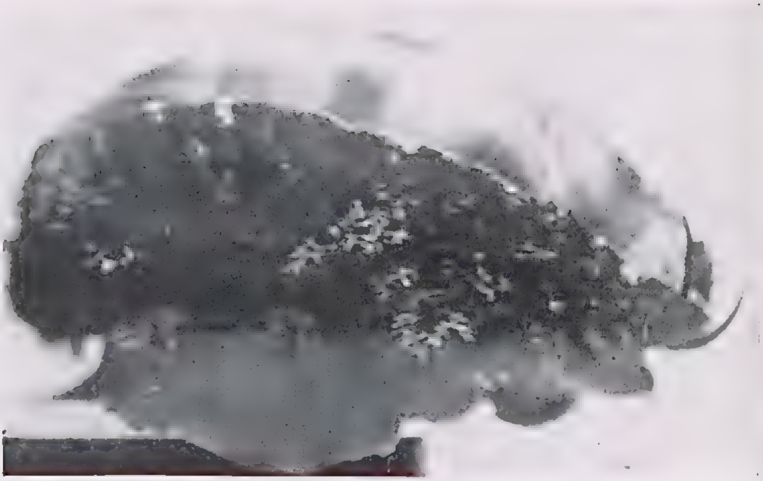


Figure 5

Figure 5, *Cypraea leviathan* Schilder-Schilder. A living animal showing the feathery, dendritic papillae, plicate mantle surface, and short siphon.

of *C. carneola* by their longer and more prominent cusps, and by the obliquely oriented outer marginals with short central cusps. In juvenile specimens the outer marginals are of the hook-shaped type described for the preceding species.

Genitalia. A bursa copulatrix is present in the females; it is a pyriform structure with a bulbous posterior section and a rounded anterior portion. The penis is a simple, elongate, conical structure similar to that in *C. carneola.*

Distribution. Eastern Polynesia exclusive of the Line Islands.

Cypraea lynx Linnaeus

Fig. 6e, Pl. 8, Fig. 2

Material Examined. Living specimens from the Hawaiian Islands and Guam, Marianas Islands; preserved specimens from the Caroline Islands; Fiji; and Marshall Islands.

Living Animals. In living animals from both Guam and the Hawaiian Islands, the mantle is creamy white with splashes of black; the papillae are cream-coloured; the proboscis and tentacles are grey; the siphon is cream-yellow; and the dorsal surface of the foot is cream veined with black. The papillae protrude as densely feathered processes. The siphon is short and simply fringed.

Mantle. The mantle of preserved specimens retains its mottled cream and black coloration. The mantle surface is faintly plicate. The papillae are of two types, smaller, simply conical processes and larger, much branched dendritic structures which appear to be about equally interspersed. A preserved mantle was well figured by Vayssière (1923). The siphon is simply fringed by a row of conspicuously projecting serrations; the siphon is bordered by clusters of densely packed, large conical and dendritic papillae.

Radula. In four specimens the radular ribbon varies from 16-19 mm. in length and from .75-1.25 mm. in width; in a specimen from Fiji there are 183 radular rows and in a specimen from the Hawaiian Islands 225. The teeth are of medium size; the medians are .07-.10 mm. wide and .12-.19 mm. wide; the admedians are of similar dimensions; the inner marginals are .09 to .11 mm. long and .11-.15 mm. wide; the outer marginals are .12-.15 mm. long and .04-.05 mm. wide. The teeth closely overlap one another in the transverse rows but are fairly well-spaced longitudinally. Tooth pattern is as in the preceding species.

Genitalia. A bursa copulatrix is present in the females; it is a heart-shaped structure lying directly below the vagina; in males the penis is a long, slender, conical structure.

Distribution. Indo-West-Pacific, including the Hawaiian Islands.

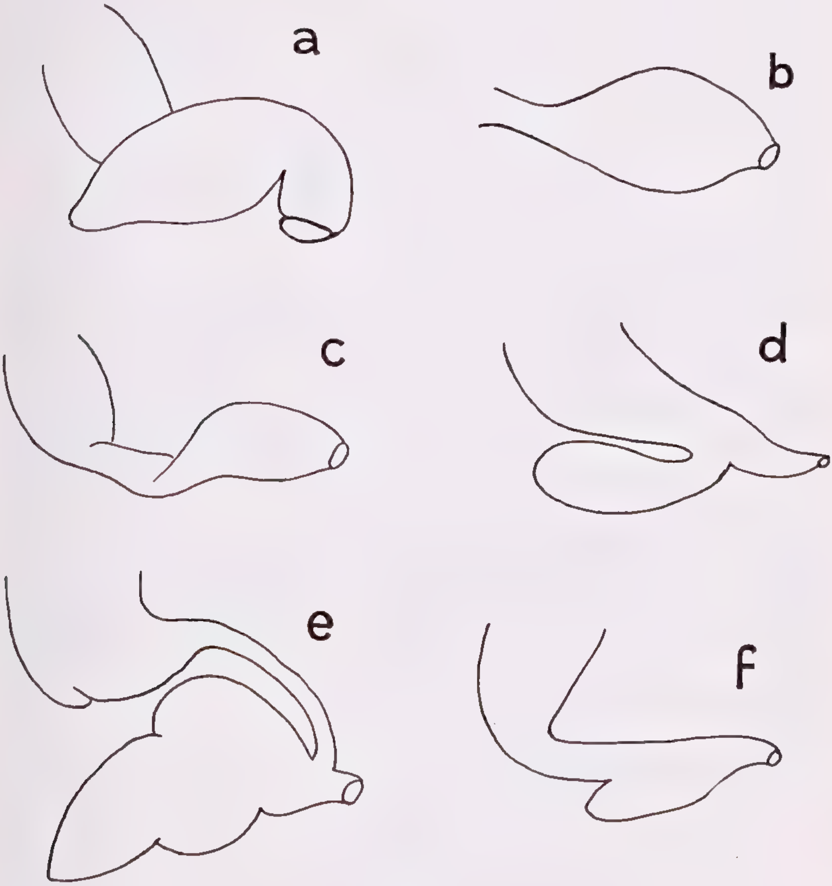


Figure 6

Figure 6, Outlines of the bursa copulatrix. a, *Cypraea argus* Linnaeus; b, *Cypraea aurantium* Gmelin; c, *Cypraea carneola* Linnaeus; d, *Cypraea mappa* Linnaeus; e, *Cypraea lynx* Linnaeus; f, *Cypraea vitellus* Linnaeus.

Cypraea reevei Sowerby

Pl. 8, Fig. 4

Material Examined. Radula of one specimen from Western Australia, June, 1960.

Mantle. Vayssière (1923) described the mantle as having ". . . plis longitudinaux très fins avec papilles simples ou bifurquées peu nombreuses; le bord du siphon pourvu de 24 à 26 papilles fongiformes."

Radula. Neither the length nor the number of rows could be determined from the fragments available; the radular ribbon is approximately 1 mm. wide. Vayssière (1923) noted 200 rows of massive teeth in his specimen. The teeth are sturdy dark brown structures with the medians well-spaced longitudinally and transversely but with the admedians and marginals slightly overlapping. The medians are .16 mm. long and .20 mm. wide; the admedians are of similar dimensions; the inner marginals .13 mm. long and .21 mm. wide; and the outer marginals .24 mm. long and .09 mm. wide. Tooth pattern is as in the preceding species. In the median tooth the anterior dome with its cusps occupies more than three-fourths of the tooth, while the cusps form less than one-fourth of the dome. The form of the tooth is similar to that which Vayssière (1923) figured.

Distribution. South-western and South Australia.

Cypraea schilderorum Iredale
(= *Cypraea arenosa* Gray, 1824)

Pl. 8, Fig. 5

Material Examined. Living and preserved specimens from the Hawaiian Islands.

Living Animal. The mantle is mottled black, brown, and white; the papillae are cream-coloured; the tentacles and proboscis are black; the foot is dorsally light tan and ventrally cream. The siphon projects as a short, simply fringed structure from the anterior canal.

Mantle. Preserved the mantle retains its mottled coloration. The mantle surface is faintly plicate. The papillae are sparse, the smaller conical papillae more numerous than the larger, branched, dendritic processes. The siphonal fringe is prominent, consisting of a single row of stiff serrations; the siphon is bordered by clusters of large conical and dendritic papillae.

Radula. The radular ribbon is 10 mm. long, 0.5 mm. wide, and is composed of 130 rows of teeth. The teeth are small: median .06 mm. long and .08 mm. wide; admedians of the same dimensions; inner marginals .08 mm. long and .09 mm. wide; outer marginals .10 mm. long and .03 mm. wide. The medians are well-spaced longitudinally; the admedians and marginals overlap. Tooth pattern is as in the preceding species.

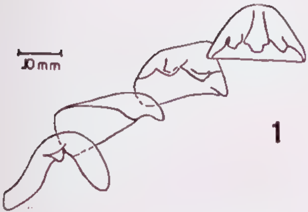
Genitalia. Males only examined; the penis is the usual slender, tapering conical structure.

Distribution. Polynesia.

PLATE 8

Radulae

Fig. 1, *Cypraea aurantium* Gmelin.
Fig. 2, *Cypraea lynx* Linnaeus.
Fig. 3, *Cypraea sulcidentata* Gray.
Fig. 4, *Cypraea reevei* Sowerby.
Fig. 5, *Cypraea schilderorum* Iredale.
Fig. 6, *Cypraea vitellus* Linnaeus.
Fig. 7, *Cypraea argus* Linnaeus.
Fig. 8, *Cypraea carneola* Linnaeus.
Fig. 9, *Cypraea leviathan* Schilder-Schilder.



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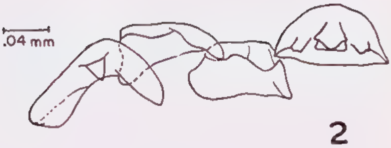

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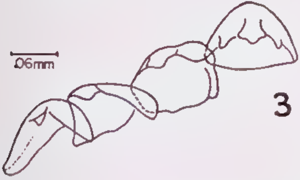

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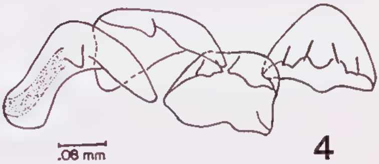

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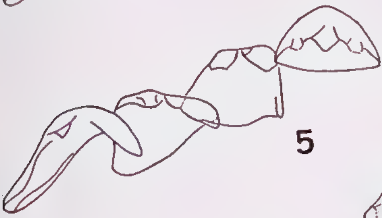

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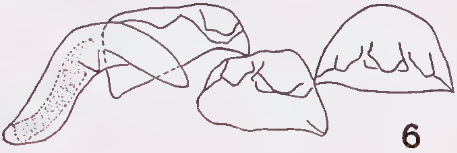

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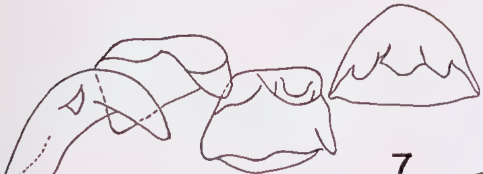

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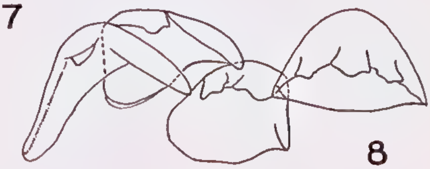

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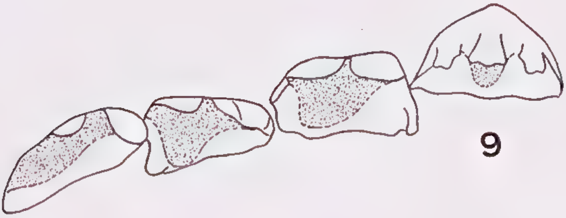

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PLATE 8

Cypraea sulcidentata Gray

Pl. 8, Fig. 3

Material Examined. Living and preserved specimens from the Hawaiian Islands.

Living Animal. The mantle is mottled black, brown, and white; the papillae are cream-coloured; the tentacles and proboscis are black; the foot is dorsally light tan, ventrally cream. The papillae project as conspicuous feathery structures from the mantle. The siphon is a short simply fringed process.

Radula. Preserved the mantle retains its mottled coloration noted above. The mantle surface is finely and evenly plicate. The papillae are prominent and numerous; small, conical papillae are more numerous than the thick-set, much-branched dendritic tufts which are scattered over the entire mantle. The siphonal fringe is simple, with a single row of prominent serrations.

Radula. In five specimens the radular length varies from 28-37 mm. and the width from .75-1 mm.; there are 100-260 rows in the radulae examined. The teeth are of medium size; the median is .11-.13 mm. long and .13-.17 mm. wide; the admedian is of similar dimensions; the inner marginals are .12-.14 mm. long and .15-.18 mm. wide, and the outer marginals .13-.18 mm. long and .04-.06 mm. wide. The teeth are closely packed and overlap both longitudinally and transversely. Tooth pattern is as in the preceding species.

Genitalia. There is a pyriform bursa copulatrix in the females; in males the penis is the usual conical structure but the tip is narrowed.

Remarks. Vayssière's (1923) illustrations of mantle and radula of "probably *sulcidenta*" are of a different species; Schilder (1936) has suggested that the figures are of a *C. cinerea.*

Distribution. Hawaiian Islands.

Cypraea vitellus Linnaeus

Fig. 2; Fig. 6f; Pl. 8, Fig. 6

Material Examined. Living and preserved specimens from the Hawaiian Islands and Guam, Marianas Islands; preserved specimens from the Caroline Islands, Lord Howe Island, Australia, Line Islands, Fiji.

Living Animal. In living animals from both the Hawaiian Islands and the Marianas Islands the mantle is cream-coloured and mottled with splashes of black; the papillae are yellow; the tentacles and proboscis are grey and the siphon is cream. The surface of the mantle is covered by fine yellow-grey granules.

Mantle. Preserved the mantle retains its mottled appearance. The mantle surface is plicate and slightly pustulose. The papillae are sparse; small, conical papillae are interspersed among the fewer, larger, much branched dendritic papillae. The pustulose mantle and the two types of papillae were figured by Vayssière (1923). The siphonal fringe is prominent, evenly spaced regular serrations forming the fringe.

Radula. In 12 specimens the length of the radular ribbon varies from 10 to 43 mm. and the width from 1 to 1.75 mm.; the number of rows varies from 164 to 274. The teeth are of medium size; the median is .10-.15 mm. long and .15-.26 mm. wide; the admedians are of similar dimensions; the inner marginals are .10-.14 mm. long and .14-.24 mm. wide; and the outer marginals .14-.24 mm. long and .04-.10 mm. wide. Except in the largest specimen examined, the teeth are well-spaced longitudinally on the ribbon; in all specimens the marginals and admedians overlap. Tooth pattern is as in the preceding species.

Genitalia. A bursa copulatrix is present in the females; in the males the penis is long and slender and, in some specimens, the tip is hook-like.

Distribution. Indo-West-Pacific to the Hawaiian Islands.

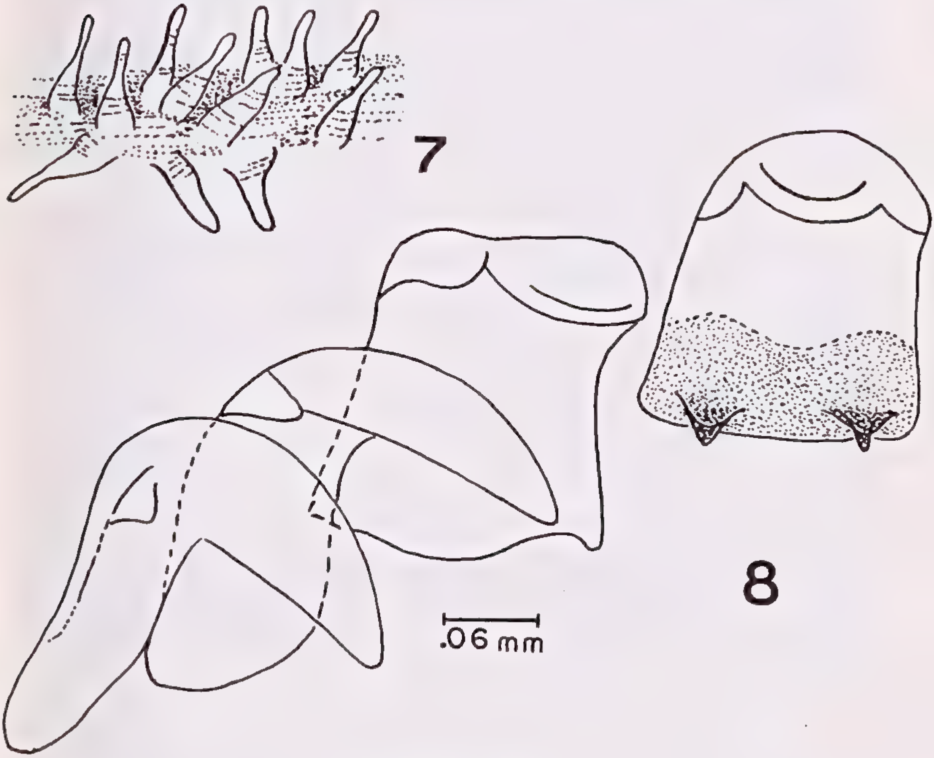
Cypraea mappa Linnaeus

Figs. 6d., 7, 8

Material Examined. 1 specimen: length, 83 mm., width 59 mm., height, 48 mm.; from Lagoon Reef, Rongutoru, Kapingamarangi, August, 1954; 1 specimen (dimensions not available) from Eniwetok, Marshall Islands, 1959.

Mantle. Preserved the mantle is light fawn with no indication of darker coloration; the papillae are the same colour as the mantle itself. The mantle surface is almost smooth, textured only by irregular, faint rugosities. The papillae are densely scattered over the entire surface of the mantle, consisting of long (2 mm.) conical projections which taper to a fine point at the terminus. The siphon is destroyed in the specimens examined.

Radula. In the specimen from the Marshall Islands the radular ribbon is 55 mm. long, 2 mm. wide, and consists of 158 rows. The teeth are large and sturdy, the medians well-separated from each other, the admedians and marginals overlapping each other in the transverse rows. The median tooth is rectangular, longer than it is broad (.25 x .24 mm.), narrower anteriorly than posteriorly. The central cusp is larger than the lateral cusps. The cusps extend over the anterior one-fourth the tooth body.



Figures 7 and 8

Figure 7, Mantle surface of *Cypraea mappa* Linnaeus.
Figure 8, Radula of *Cypraea mappa* Linnaeus.

The base is rounded at the corners and bears medially a pair of projecting basal denticles. The admedian is larger than the median (.30 mm. long and .24 mm. wide) and oriented so that the elongate median cusp projects medio-posteriorly; the base is curved, the corners terminating in projecting cusps. The admedian barely overlaps the median tooth but is itself overlapped by the elongate inner marginal which is .33 mm. long and .24 mm. wide; the central cusp of the inner marginal is elongated as a blade-like projection. The outer marginal is similar to the inner marginal but narrower and the central cusp curves more prominently; it is .36 mm. long and .10 mm. wide.

Genitalia. A bursa copulatrix is present in the female; in the Caroline Island specimen the bursa is 9 mm. long, 3 mm. wide, and consists of an oval structure lying posterior to the vagina.

Distribution. Indo-West-Pacific, excluding the Hawaiian Islands.

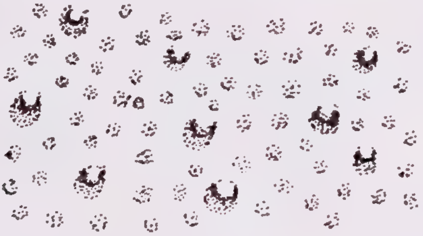
Cypraea talpa Linnaeus

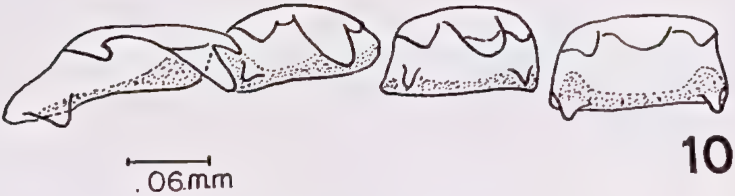
Figs. 9, 10

Material Examined. Living and preserved animals from the Hawaiian Islands; preserved specimen (62 mm. long, 30 mm. wide), from Kapingamarangi, Caroline Islands, August, 1954.

Living Animals. There is a considerable amount of colour variation in the mantle of specimens observed in the Hawaiian Islands; in one specimen the mantle was fawn with green spots outlined in black; a second specimen was black spotted with minute flecks of fluorescent green; a third specimen was pure black. The papillae are leaf-like projections and the mantle surface is granular. The siphon is not fringed but projects as a smooth process from the anterior canal.

Mantle. Preserved the mantle retains its original coloration to some extent. The mantle surface is conspicuously granular, larger pustules





Figures 9 and 10
Figure 9, Mantle surface of *Cypraea talpa* Linnaeus.
Figure 10, Radula of *Cypraea talpa* Linnaeus.

representing the contracted papillae and smaller pustules the granular texture noted above in the living animal. The siphon is smooth.

Radula. In the specimen from Kapingamarangi, the radular ribbon is 1.5 mm. wide; the length and number of rows were not determined. The teeth are very broad and evenly spaced but crowded both longitudinally and transversely on the radular ribbon. The median (.06 mm. long and 1.4 mm. wide) is broader than it is long. The central cusp is larger than the lateral cusps; there is a pair of laterally situated basal denticles on the posterior corners of the tooth; and an internal tract is present consisting of a narrow basal portion and wide antero-lateral sections. The admedians and inner laterals are similar to the median in both dimensions and structure. The outer marginals also resemble the median but are wider (.06 mm. long and .21 mm. wide), the central cusp is elongated as a medially oriented blade, and only a single basal denticle is visible.

Genitalia. A bursa copulatrix is present in females, consisting of a pyriform structure; in the specimen from Kapingamarangi the bursa is 5 mm. long and 3 mm. wide. In males the penis is a long, slender, conical structure.

Distribution. Indo-West-Pacific, including the Hawaiian Islands.

Cypraea testudinaria Linnaeus

Figs. 11, 12

Material Examined. 1 specimen: 99 mm. long, 50 mm. wide, 40 mm. height; from Tubajon Bay, Duragit, Philippine Islands, July, 1957 (Zoological Museum of Copenhagen).

Mantle. An observer at Eniwetok, Marshall Islands, has noted that in living animals, "The mantle is absolutely clear, with very long papillae all over it" (Fellows, personal communication). Preserved, the mantle is grey, relieved by cream-coloured papillae; the proboscis and tentacles are black. The mantle surface is comprised of minute rolled ridges separated by thread-narrow grooves. The papillae are sparse but prominent, consisting of elongate nipple-like structures which are evenly distributed over the surface of the mantle. The papillae are broader at the base than at the tip where they taper to a blunt terminus. The majority of the papillae are single structures, but there are occasional bifid papillae which are particularly noticeable near the foot. The siphon is not fringed, consisting of a thick ridge of tissue; it is bordered by a single row of large conical and bifid papillae.

Radula: The radula is a heavy structure with the teeth closely spaced and overlapping. It is 67 mm. in length, 3 mm. in width, and composed of 138 rows. The radula differs from that in other species of *Cypraea* in that the outer marginal teeth are much reduced in size (.21 mm. long, .09 mm. wide) and sculpture, consisting of rudimentary structures which nestle against the well-developed inner marginals. The inner marginals (.45 mm. long, .27 mm. wide) have a blade-like cusp and wide body. The admedians (.51 mm. long, .42 mm. wide) are longer than they are broad, with a single median cusp and reduced lateral cusps. The median (.42 mm. long, .42 mm. wide) is trapezoidal in shape with a blunt median cusp and reduced lateral cusps; the base of the tooth flares into two projecting basal cusps but there are no denticles or internal bracts present.

Genitalia. The animal dissected is a female, and a bursa copulatrix is present. It is an elongate, pyriform structure, 10 mm. in length, and 4 mm. in diameter.

Osphradium and Ctenidium. The ctenidium is the usual horse-shoe shaped structure with one leg longer than the other; the filaments are one-quarter the length of the longer leg. The osphradium is small, less than one-quarter the length of the ctenidium, and is bifid, consisting of a single long axis with only a vestige of a second branch.

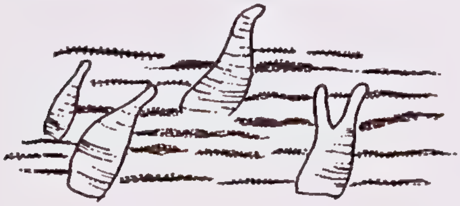
Remarks. I have not had the opportunity to compare Haller's (1890) description of *C. testudinaria* with the specimen described above.

Distribution. Indo-West-Pacific, excluding the Hawaiian Islands.

DISCUSSION

Nine of the twelve species described above—*C. argus, C. aurantium, C. carneola, C. leviathan, C. lynx, C. reevei, C. schilderorum, C. sulcidentata,* and *C. vitellus*—are characterized by common features in the radula and mantle, and a bursa copulatrix is present in females of the species. Three—*C. mappa, C. talpa,* and *C. testudinaria*—although bearing a bursa copulatrix in the females, differ in radular pattern and mantle characteristics.

On the basis of radular pattern, the nine species fall into Troschel's subgenus *Lyncina.* Troschel (1863) did not further characterize his subgenus anatomically. The present study discloses these additional features which appear to be common to the cowries bearing rounded or semicircular median radular teeth: the mantle is plicate and occasionally granular; the papillae are of two types, small, conical processes and larger, dendritic tufts; the siphon is short and fringed with a single row of evenly spaced serrations which are of uniform size; and the mantle colour ranges from grey to black or brown, mottled with white or cream, with papillae which are cream or yellow. The cowries which are characterized by these features appear to be restricted to the Indo-West-Pacific; four (*C. argus, C. carneola, C. lynx,* and *C. vitellus*) are widely distributed within the province; three (*C. aurantium, C. schilderorum,* and *C. leviathan*) are limited in their distribution to the Pacific; and one (*C. sulcidentata*) is known only from the Hawaiian Islands.



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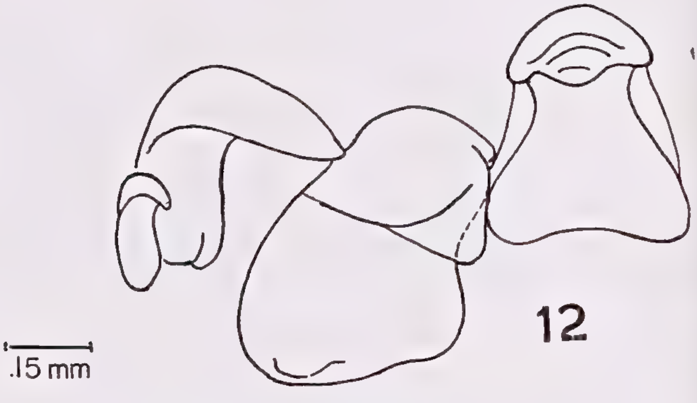

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Figures 11 and 12

Figure 11, Mantle surface of *Cypraea testudinaria* Linnaeus.
Figure 12, Radula of *Cypraea testudinaria* Linnaeus.

Troschel's subgenus *Lyncina* thus appears to include a group of species which have a number of distinctive anatomical characteristics and which appear to be zoogeographically limited in their occurrence to the Indo-West-Pacific. Of the six species originally proposed by Troschel (1863) as being included in *Lyncina,* four (*C. argus, C. carneola, C. lynx,* and *C. vitellus*) can be included in the more broadly characterized subgenus. Thiele's (1931) removal of *C. mappa* is justifiable on anatomical grounds: with its rectangular median tooth, slightly rugose mantle, and long conical papillae, *C. mappa* is quite distinct from the other species. Thiele's (1931) inclusion of *C. aurantium* is also justifiable on anatomical grounds and I cannot agree with the Schilders' (1938-1939) removal of this species to *Callistocypraea,* which includes *C. testudinaria* among other species. With its rectangular median tooth; long, nipple-like papillae; uniform mantle colour; and bifid osphradium (the only other known species with a bifid osphradium is *C. hesitata*), *C. testudinaria* is anatomically quite distinct from *C. aurantium.* Nor can I agree with the Schilders' (1938-1939) removal of *C. argus* to *Talparia* which includes *C. talpa.* The broadly rectangular median tooth with basal denticles and internal bracts, granular mantle, and smooth siphon of *C. talpa* are again quite distinct from the anatomical pattern which is characteristic of *Lyncina.* Thiele's (1931) inclusion of *C. reevei* in *Lyncina* is justifiable, but on the basis of radular pattern only at the present time; when the mantle and genitalia of this species are examined, they will probably also be found to be of the *Lyncina* type.

The radular pattern recognized by Troschel as characteristic of *Lyncina* is comparable to that I previously described as R4 (Kay, 1960), one of four patterns then distinguishable among the various species of *Cypraea* which I had examined. At that time *C. tigris* was included within the R4 pattern; I now feel the radular teeth of *C. tigris* are sufficiently distinct to be excluded from the pattern. With the exclusion of *C. tigris* from the R4 pattern, all species I previously included in the pattern fall within Troschel's subgenus *Lyncina.*

The recognition of mantle features as characteristic of a group of cowry species is also a departure from views I have previously expressed (Kay, 1960). The very clearly seen association of certain features of the mantle with both radular patterns and genitalia found in *Lyncina* leads me to include these characters in more broadly defining Troschel's subgenus *Lyncina.*

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